

Feb. 28, 1956

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2,736,177

KNITTING MACHINE AND METHOD

Filed Oct. 18, 1951

8 Sheets-Sheet 1

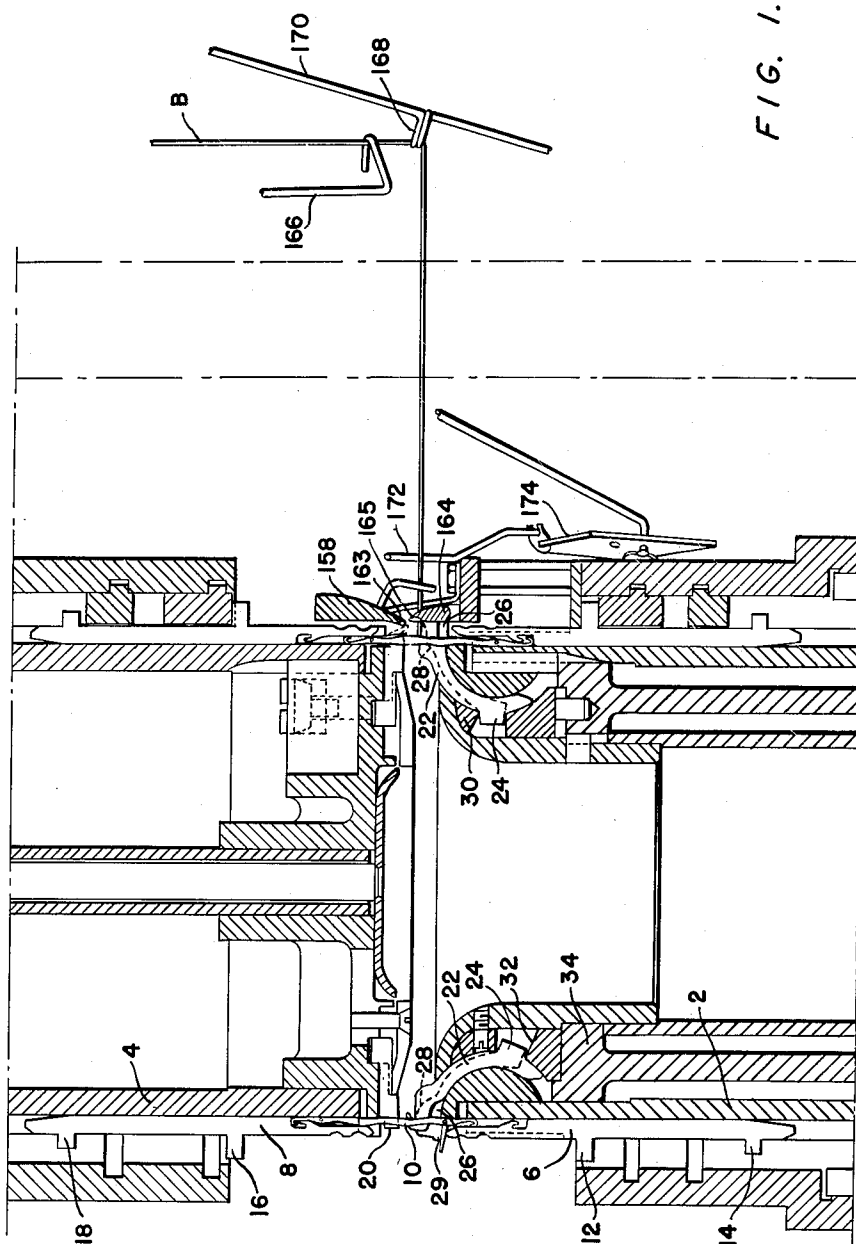


FIG. 1.

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8 Sheets-Sheet 2

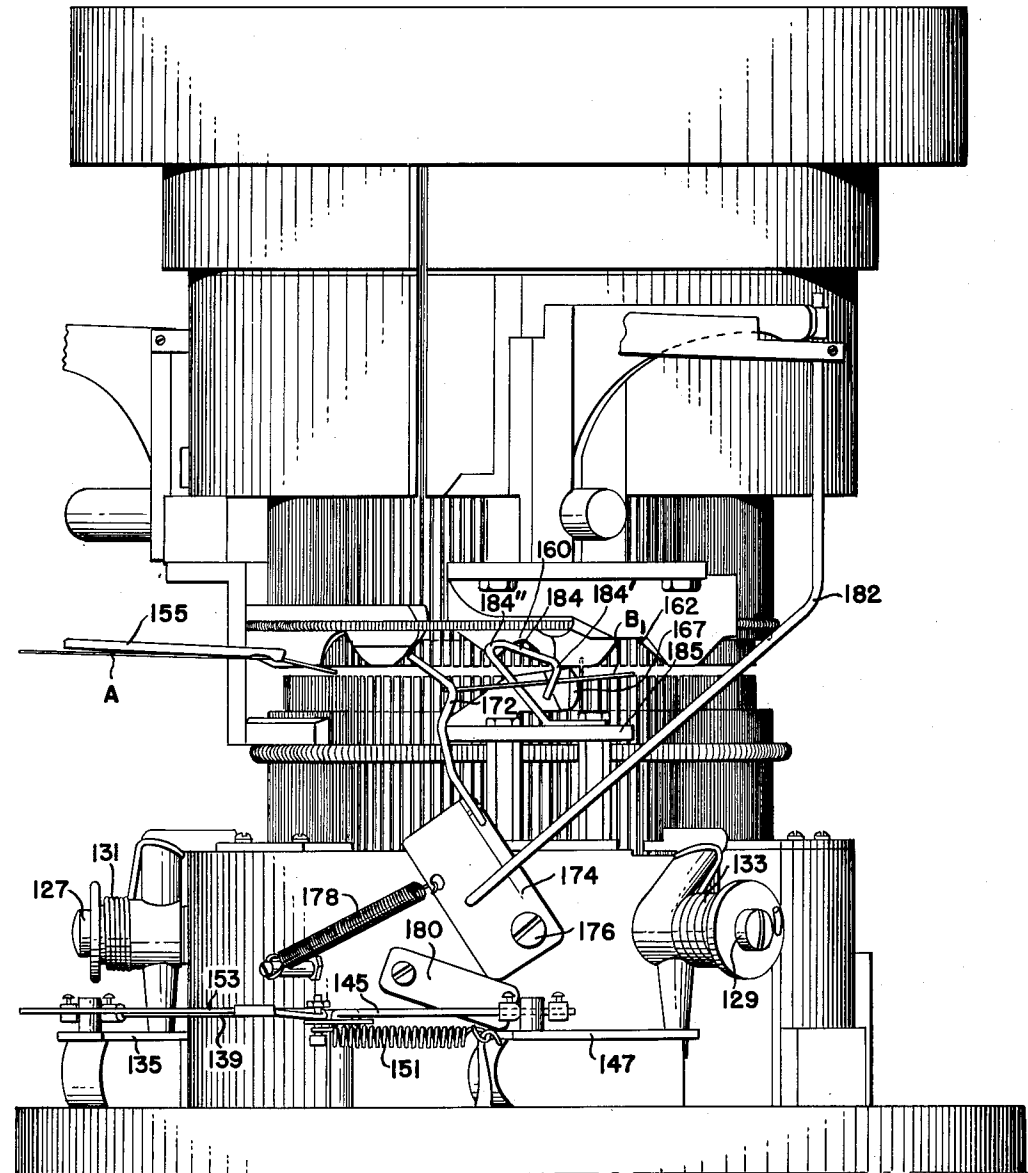


FIG. 2.

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8 Sheets-Sheet 3

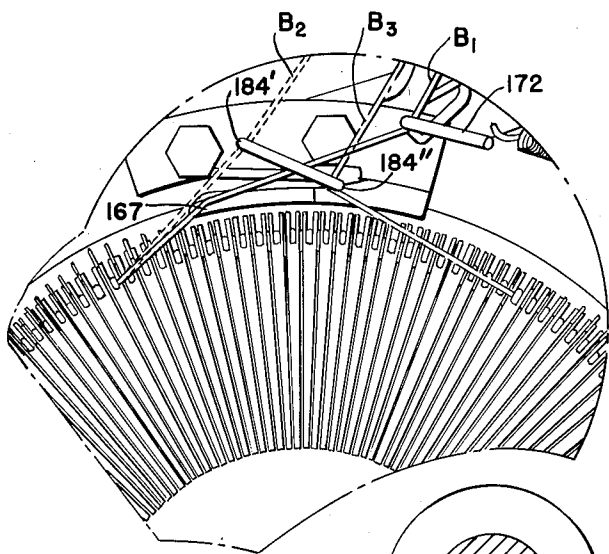


FIG. 4.

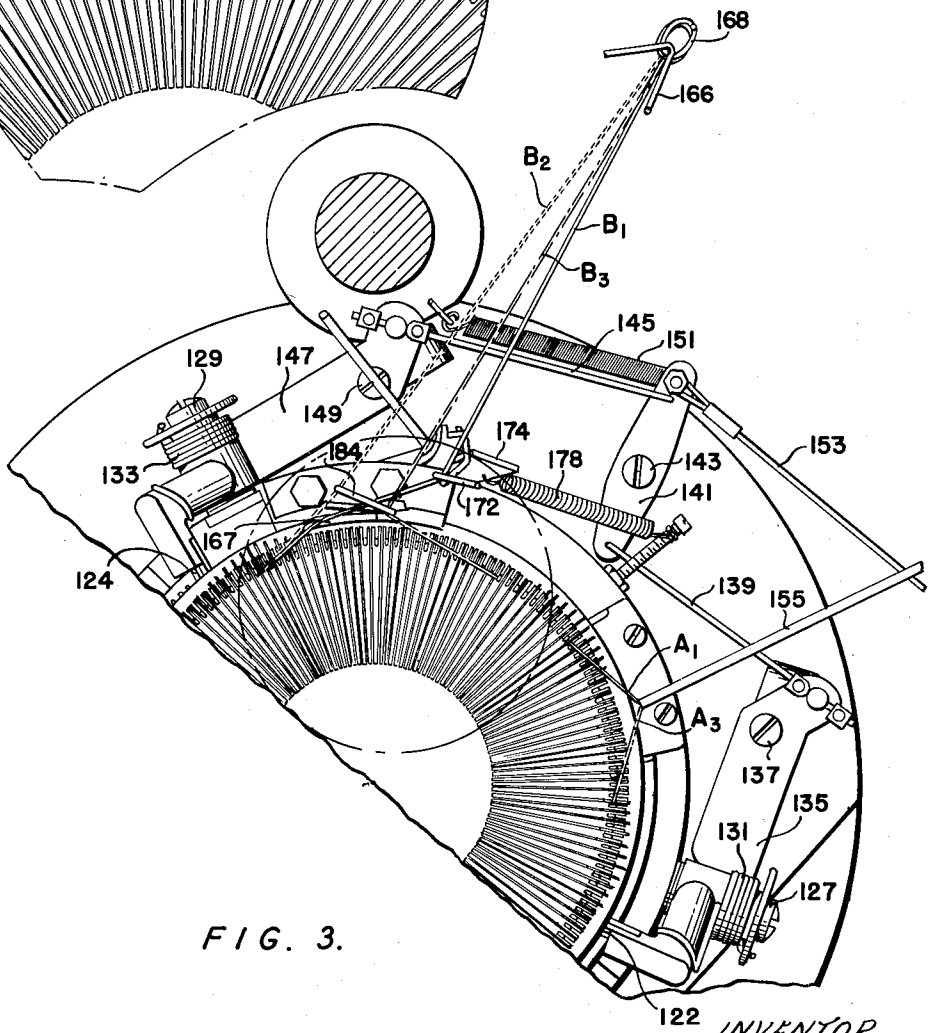


FIG. 3.

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8 Sheets-Sheet 4

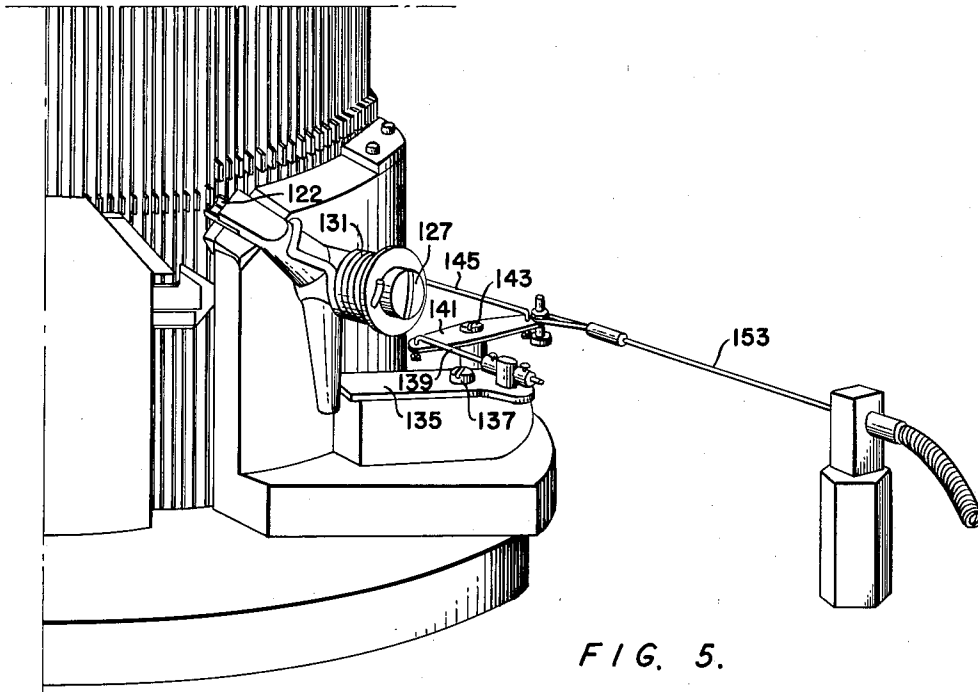


FIG. 5.

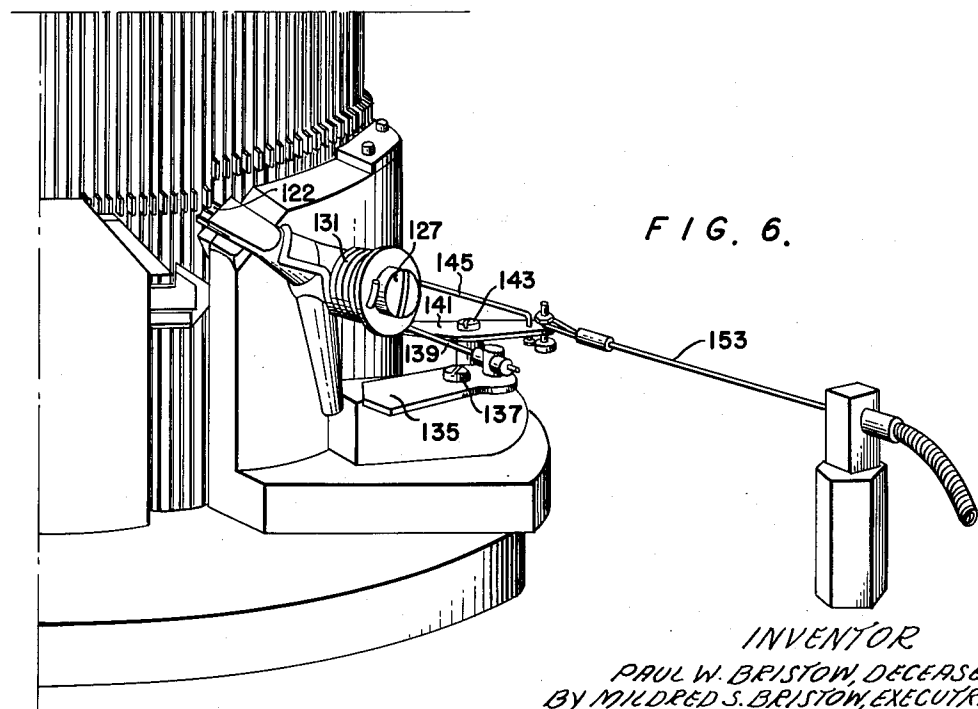


FIG. 6.

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8 Sheets-Sheet 5

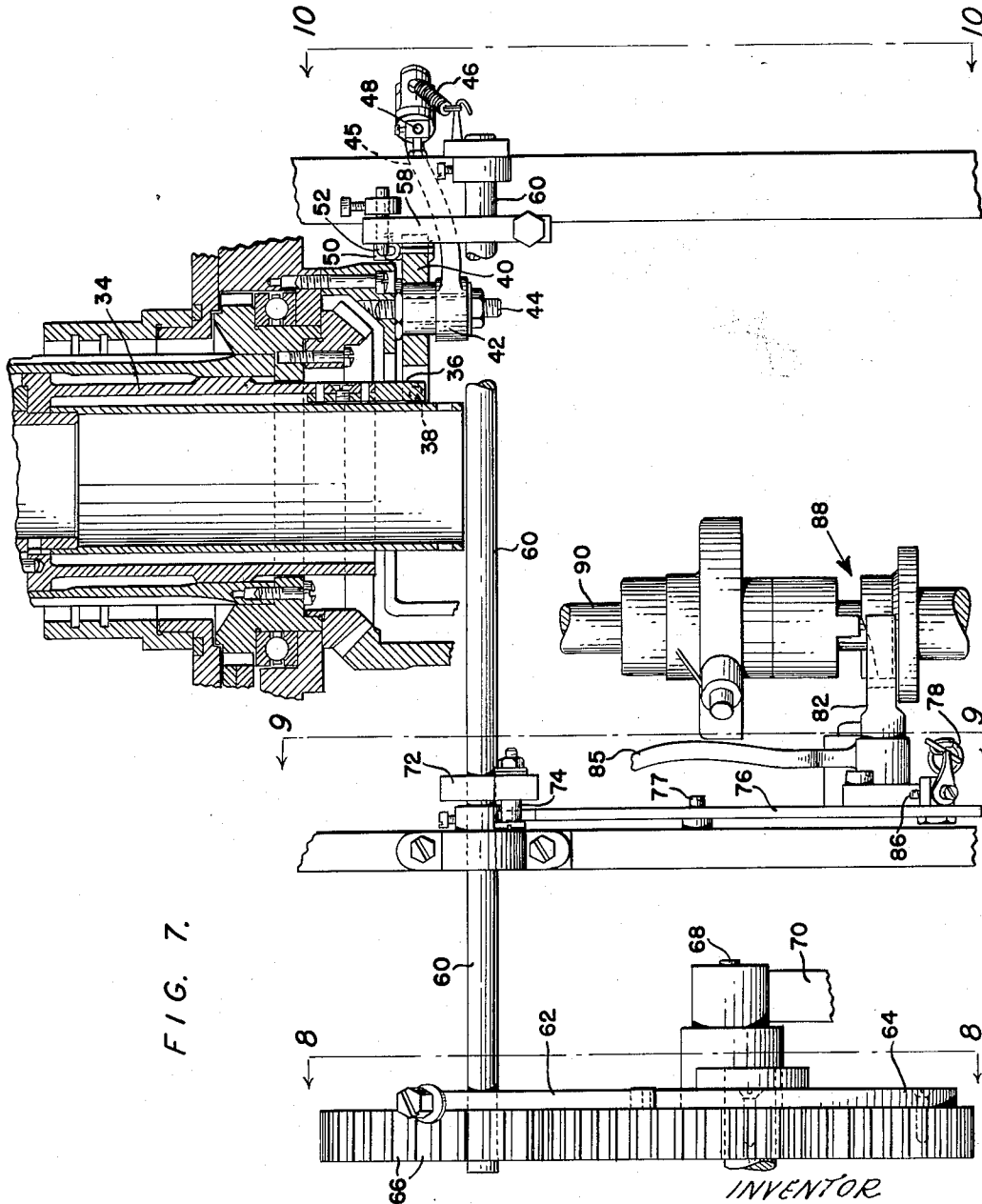


FIG. 7.

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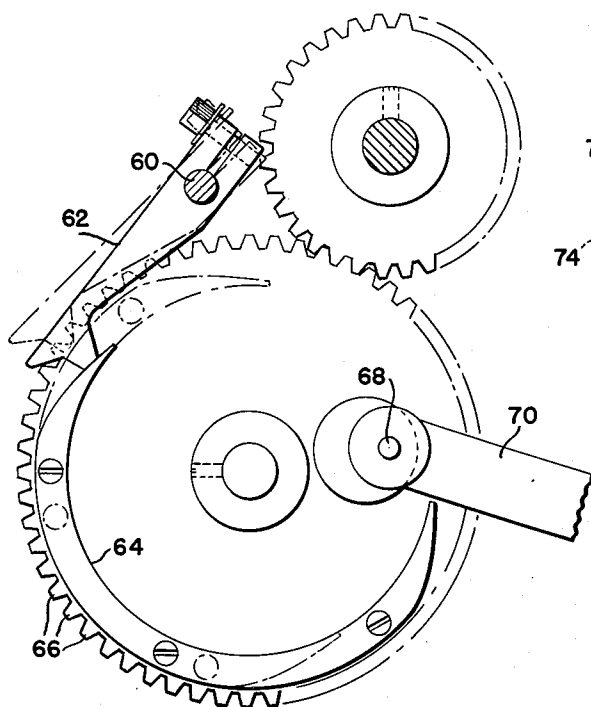


FIG. 8.

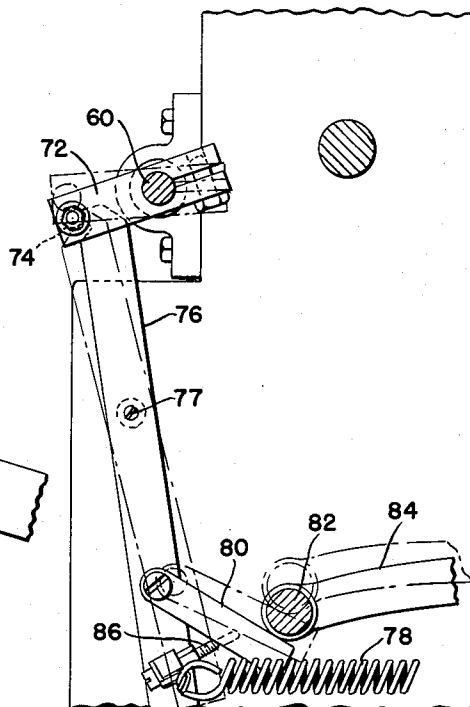


FIG. 9.

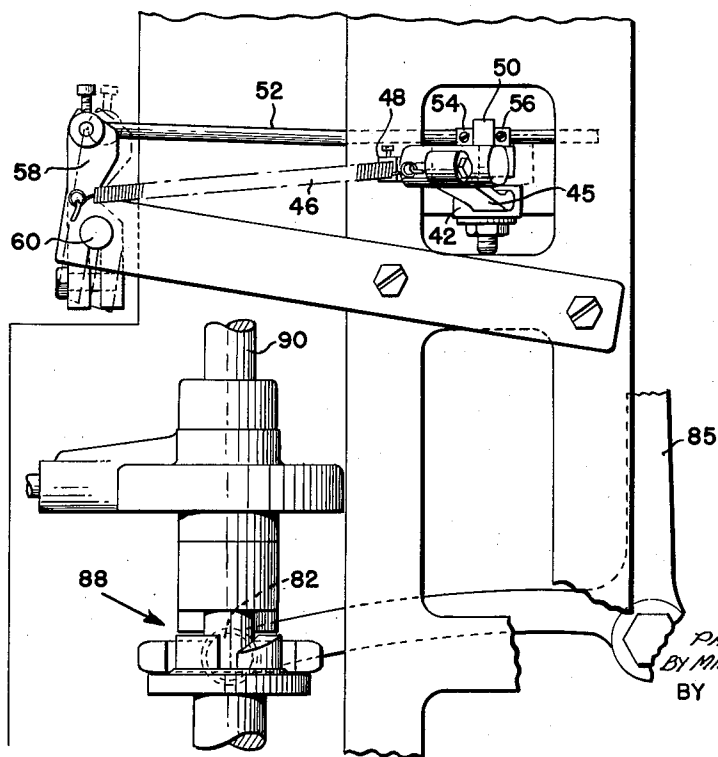


FIG. 10.

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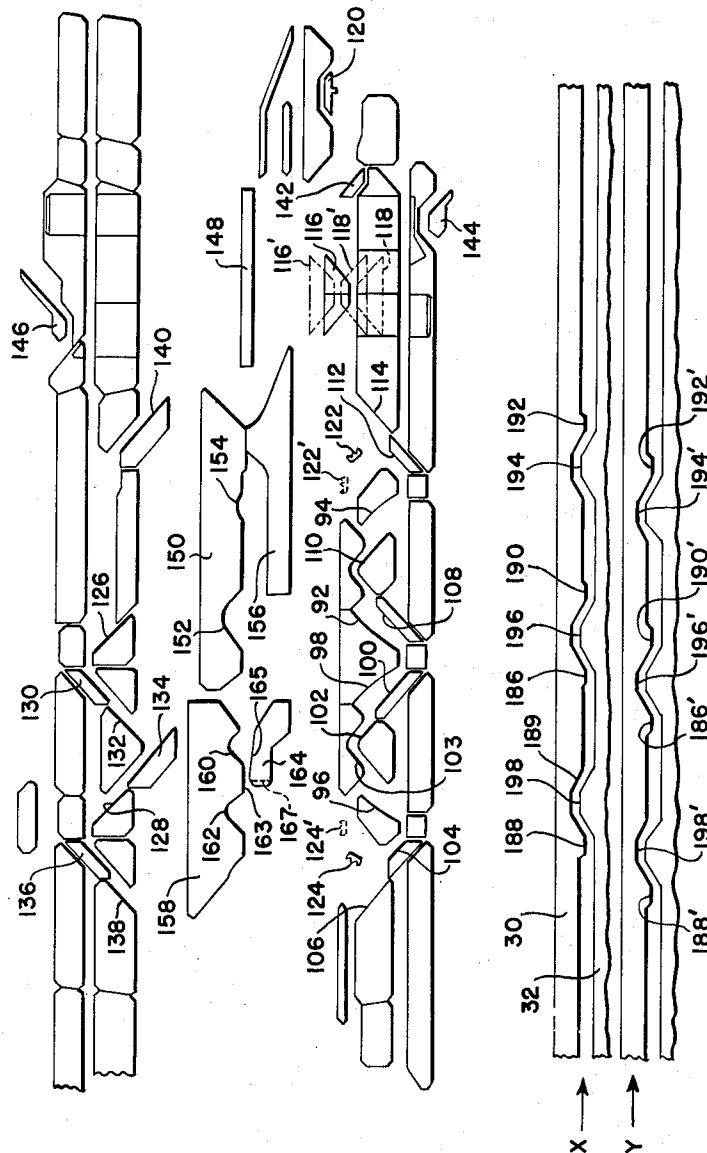


FIG. 11.

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8 Sheets-Sheet 8

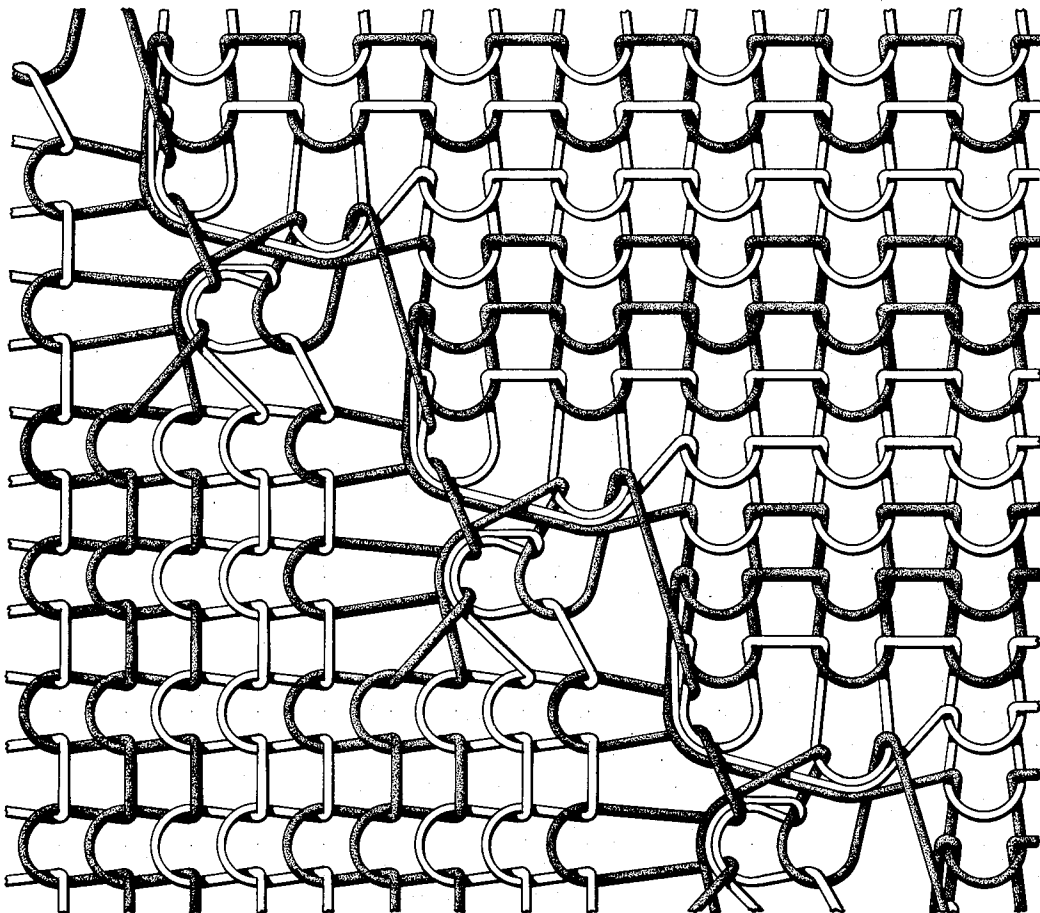


FIG. 12.

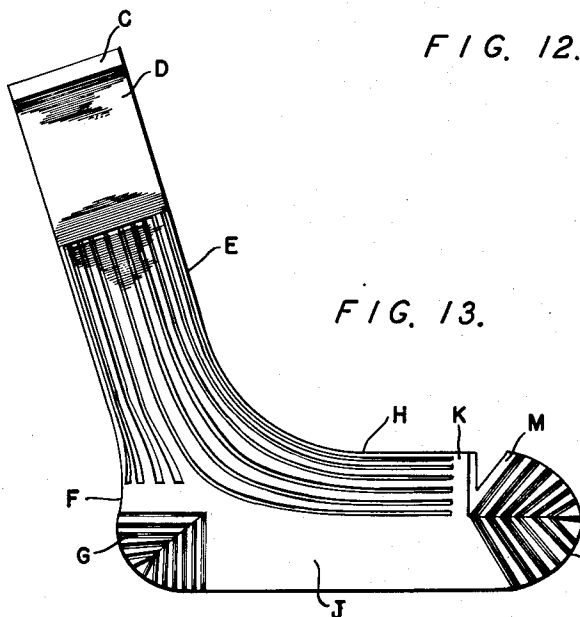


FIG. 13.

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KNITTING MACHINE AND METHOD

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Application October 18, 1951, Serial No. 251,868

24 Claims. (Cl. 66—14)

This invention relates to knitting machines of the superposed cylinder type and, particularly, to improvements therein having to do with the two-feed knitting of heels and toes.

Superposed cylinder knitting machines are well-known and are particularly designed for the knitting of stockings having rib tops such as 1 x 1 rib and legs and insteps which are provided with so-called broad ribs or with decorative structure of links-links type. In such machines, the cylinders closely approach each other for the transfer and proper support of needles and the machines are provided with arcuate sinkers which are supported inside the circle of needles, being arranged to be projected between the needles by cams which are also located inside the needle circle. In view of the fact that there is a cage of needles existing during the formation of ribbed fabric, it is impossible to provide yarn feeding or controlling devices having portions inside the needle circle. In order to insure proper handling of yarn during reciprocatory knitting of heels and toes, so-called bluff sinkers are provided which are controlled by the sliders of needles raised or picked out of action to prevent improper entrapment of yarn.

It is recognized that two-feed knitting is highly advantageous from the standpoint of rapidity of production and, in particular, that two-feed reciprocatory knitting of heels and toes is advantageous in view of the fact that the production rate of the machine is particularly lowered during reciprocatory knitting. Two-feed knitting of heels and toes is also desirable because no eyelets are then produced due to starting and discontinuing a second feed.

Various problems arise, however, in attempting to secure two-feed reciprocatory knitting in machines of the superposed cylinder type. The problems involve the matters of feeding of yarns, the guarding of needle latches, the control of sinkers, and the operation of bluff sinkers. As will become more apparent hereafter, these various matters tend to conflict with each other in several fashions. For example, the provision of desirable latch guards is inhibited by the sinker operations and, in turn, requires special feeding of the yarns, particularly the auxiliary yarn inasmuch as the main and auxiliary yarn feeds must be close together in order to leave proper space for picking during the reciprocatory knitting of heels and toes. Sinker operation, and particularly the proper operation of bluff sinkers, also involves interference if the usual types of relationships of operating cams are involved.

The general object of the present invention is to provide a knitting machine of the superposed cylinder type which is capable of properly knitting stockings having two-feed heels and toes consistently with the securing of normal broad rib or links-links structure in the leg and with the provision of conventional welt and top formations. In accordance with the present invention, eyelets are avoided in the starting and discontinuing the operation of a second feed. Subsidiary objects of the present invention are concerned with proper controls of sink-

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ers during reciprocatory knitting, there being provided for this purpose circularly shiftable sinker cams arranged to change the phases of sinker operations during forward and reverse strokes of the needle cylinders.

Other objects of the invention are concerned with the provision of suitable latch guarding arrangements and, in particular, with the feeding of yarns so as to supplement the latch guards in insuring that needles will not fail to take yarns to form stitches.

Still another object of the invention has to do with various details of the interrelationships of the machine parts to provide proper cooperation thereof.

These and other objects of the invention particularly relating to details of construction and operation will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a vertical section through the portions of the machine adjacent to the contiguous ends of the cylinders;

Figure 2 is an elevation of the same portions of the machine;

Figure 3 is a fragmentary horizontal section taken generally above the lower cylinder;

Figure 4 is an enlargement of certain of the parts within the circle shown in construction lines in Figure 3;

Figure 5 is a perspective view showing the control of a narrowing picker when positioned to raise a single needle during a reciprocation;

Figure 6 is a view similar to Figure 5 but showing the narrowing picker when positioned to raise two needles during a reciprocation;

Figure 7 is a fragmentary elevation, partly in section, showing in particular the means for controlling oscillation of the sinker cams;

Figure 8 is a vertical section taken on the plane the trace of which is indicated at 8—8 in Figure 7;

Figure 9 is a vertical section taken on the plane the trace of which is indicated at 9—9 in Figure 7;

Figure 10 is a fragmentary elevation viewed from the plane the trace of which is indicated at 10—10 in Figure 7;

Figure 11 is an inside development of the cams and other elements acting on the sliders and sinkers, the cams acting on the sinkers being illustrated in two positions at X and Y, the position at X showing these sinker cams in their clockwise position, while the position at Y shows them in their counterclockwise position;

Figure 12 is a diagram showing a portion of the inside of a heel suture of a stocking knit by the machine; and

Figure 13 is a diagrammatic elevation of a typical sock such as may be knit by the machine.

The present knitting machine is of the well-known superposed cylinder type including lower and upper cylinders 2 and 4, respectively, which are slotted for the reception of lower sliders 6 and upper sliders 8 which control needles 10. The lower sliders 6 are provided with upper butts 12 and lower butts 14 while the upper sliders 8 are provided with lower butts 16 and upper butts 18. These butts are differentiated in conventional fashion so as to be selective for transfer purposes and for the knitting of heels and toes. The particular butt arrangements will be referred to in greater detail hereafter. Verge bits 20 carried by the upper cylinder assembly cooperate with needles which are located in the upper cylinder for the production of rib stitches. Sinkers 22 are associated with the lower cylinder 2 and are provided with butts 24 which are arranged to be acted upon by suitable cams generally indicated at 30 and 32 and as hereafter more fully described. Associated with the sinkers which are in the sole series of needles are bluff sinkers 26 provided with the usual shoulders or ledges 28 and with projections 29 which are engaged

by laterally extending lugs on lower sliders for the general purposes described in detail, for example, in the patent to Bentley et al. 1,986,317, dated January 1, 1935. These bluff sinkers are provided with suitable butts also arranged to be acted upon by the sinker cams.

The cams 30 and 32 are supported by the sinker cam sleeve 34 which is generally stationary but, in the present machine, is adapted to have small oscillatory movements during reciprocatory knitting for purposes hereafter detailed.

At its lower end the sleeve 34 is provided with a projecting portion 36 which is arranged to be abutted by a pair of adjustable screws 38 carried by an arm 40 secured to a hub 42 which is journaled for rocking movements upon a stud 44. The hub 42 is provided with an arm 45 which is acted upon by a spring 46 normally urging it against an adjustable stop 48. The arm 40 is provided with an ear 50 through which passes a rod 52 provided with collars 54 and 56 on opposite sides of the ear 50. The rod 52 is pivoted at its forward end in a lever 58 which is secured to a shaft 60 carrying an arm 62 arranged to be acted upon by a cam 64 carried by the usual gear 66 which mounts the crank pin 68 actuating the connecting rod 70 for the purpose of rocking the usual gear segment which imparts oscillatory movements to the needle cylinder during the knitting of heels and toes. The gear 66 makes a complete revolution for each complete reciprocation of the needle cylinders. Another arm 72 secured to the shaft 60 is provided with a pin 74 with which cooperates a lever 76 pivoted to the frame at 77 and normally urged in a counterclockwise direction, as viewed in Figure 9, by a spring 78. To the lever 76 there is adjustably secured an extension 80 adapted to be engaged by the forward end of a lever 84 which, as is conventional, carries a pin 82 arranged to disconnect the clutch 88 which controls the rotation of the usual fabric take-up rollers and fabric-receiving can by the shaft 90, the lever 84 for this purpose being rocked through the medium of an arm 85 in conventional fashion from the main cam drum of the machine. As is usual in machines of this type, the fabric-receiving can rotates with the needle cylinders during circular knitting of the legs and foot portions of stockings but is maintained stationary, by disengagement of clutch 88, during reciprocatory knitting of heels and toes. The forward end of the arm 84 is arranged to engage the extension 80 of lever 76 so as to rock it against stop 86, against the action of spring 78, during reciprocatory knitting. During circular knitting, when the fabric-receiving can is rotating, the parts occupy the position illustrated in dash-dot lines in Figure 9 so that the lever 76 engages beneath pin 74 and holds the shaft 60 in the position which it assumes when rocked outwardly by cam 64. In other words, during rotary knitting, the shaft 60 remains stationary while, during reciprocatory knitting of heels and toes, the arm 62 follows the cam 64 to impart oscillating movements to the sinker cam sleeve 34. As will become apparent hereafter, the movements of the sinker cams produced about the vertical axis of the cylinders are opposite the directions of oscillation of the cylinders; when, for example, the needle cylinder is rotating counterclockwise, the sinker cams are shifted to a clockwise position and held there by cam 64 during the continuation of the counterclockwise stroke; on the other hand, during a clockwise stroke, the sinker cams are held in a counterclockwise position limited by stop 48 under the action of spring 46, this position being assumed when the cam 64 is not acting upon arm 62. It will be evident that the latching of shaft 60 during rotary knitting could be controlled in other fashion from the main cam drum, but the controlling connections to the fabric-receiving can provide a convenient control, being shifted at the same times as those at which latching is to be effected or released.

Reference may now be made to the cam development constituting Figure 11. The forward stitch cam at the main feed which acts upon the upper butts of sliders in the lower cylinder is shown at 92. The corresponding reverse stitch cam at the main feed is at 94. The forward and reverse lower stitch cams at the auxiliary feed are respectively shown at 96 and 98. During circular knitting, the upper butts 12 of the lower cylinder sliders are lowered by stitch cam 92 and are raised to clearing level by the successive actions of cams 100 and 102. They then pass below stitch cam 96, taking yarn at the second or auxiliary feed, and are cleared by the following cams 104 and 106. During reverse reciprocating strokes the upper butts of the lower sliders are depressed by stitch cam 98 and their needles seize yarn at the auxiliary feed. The stitches thus drawn are cleared by the successive actions of cams 108 and 110, and the lower slider butts 12 then pass under the stitch cam 94 to cause their needles to take yarn at the main feed, the drawn stitches being then cleared by the successive actions of cams 112 and 114. It will be noted that there are only three knitting points at which the lower cylinder needles are at their lower stitch-drawing positions, the center stitch cam serving, by edge 92, as the run down stitch cam for the main feed and, by edge 98, as the reverse stitch cam for the auxiliary feed. This enables the entire set of stitch cams to be located compactly within half the circumference of the cylinders; but difficulties then arise in feeding the auxiliary yarn which are solved as hereafter described.

Cams 116 and 118, which are arranged to engage only long upper butts 12, are mounted and controlled for axial movements between the positions illustrated at 116 and 118 and the positions illustrated at 116' and 118', respectively, the latter positions being assumed during heel and toe knitting.

A dropper picker 120 located as shown, and arranged to be moved into and out of active position in conventional fashion, is arranged to engage the upper butts of lower cylinder sliders so as to lower three successive sliders upon each stroke of the needle cylinders during heel and toe widening. Raising pickers are provided at 122 and 124 and are adapted to raise selectively either one or two lower cylinder sliders upon each reciprocatory stroke, the full line positions of these pickers which are illustrated being those positions in which they are respectively adapted to raise two sliders on each stroke, while the dotted positions illustrated at 122' and 124' are the positions which they assume as upper butts 12 ride beneath them.

The various cams acting on the lower butts of upper cylinder sliders will now be described.

At 126 there is illustrated the forward stitch cam at the main feed, while at 128 there is shown the forward stitch cam at the auxiliary feed. As upper cylinder sliders move toward the left in Figure 11, they are raised by the action of cam 126 so that their associated needles take yarn at the main feed. They are then depressed by the successive actions of cams 130 and 132 to effect clearing of the stitches. Cams 134 and 128 then again raise the upper sliders to cause their associated needles to take yarn at the auxiliary feed and the stitches thus drawn are cleared by the successive actions of cams 136 and 138, the cam 140 then raising the upper cylinder sliders for the approach to the main feed stitch cam 126.

Conventional transfer actions of the needles between the two cylinders are effected by the usual cams 142, 144 and 146. The cam 142 raises the lower sliders at desired times by action upon their upper butts 12 for the production of links-links work. The cam 144 acts upon lower butts 14 which are selectively arranged in different lengths to provide for transfers for the production of 1 x 1 ribs or broad ribs, the cam 144 having three selective positions for this purpose. The upper transfer cam 146 which acts upon the upper butts 18 of the upper cylinder

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sliders, which butts are of three lengths for the production of 1 x 1 rib fabric, broad rib fabric, or half-round broad rib fabric, has four selective positions for engaging the butts of these various lengths plus an inactive position. At 148 there is illustrated the conventional cam for providing, by control of the needles, for proper release and seizure of the needles by the respective sliders. The transfer operations involved in the present machine are essentially conventional and need not be further described.

As will become more apparent hereafter, the present invention is concerned to a considerable extent with the provision of latch guards for the needles. An upper main feed latch guard is shown at 150, being provided at its lower edge with cut-outs 152 and 154 for the movement of latches at required times. A lower main feed latch guard is shown at 156 which lies closer to the needle cylinder than the guard 150 where they join. An upper auxiliary feed latch guard is provided at 158 and has a pair of cut-outs 160 and 162 between which there is a lower edge 163 which has the position and form illustrated most clearly in Figure 1. A lower auxiliary feed latch guard at 164 has an upper edge at 165 which is positioned relatively to the edge 163, just referred to, as illustrated in Figure 1, the edge 163 lying closer to the needle cylinder than the edge 165. This lower latch guard 164 is also provided with a bevelled trailing end shown at 167 (Figures 3 and 4).

Yarns are fed at the main feed from the conventional interchangeable fingers of which one illustrated at 155 is shown as feeding a main yarn A in Figure 2. As is usual these yarn fingers are arranged to feed main yarns selectively with proper overlaps, the yarns being controlled by conventional clamps and cutters.

An auxiliary yarn B passes downwardly from the supply and is engaged by a conventional spring-controlled take-up 168 which takes up slack during reciprocatory knitting. From the loop 168 of take-up 170 the yarn B passes through a hook 166 and thence passes, being at times selectively engaged by, a wire hook 172 which is carried by a plate 174 pivoted at 176 to the frame and normally urged counterclockwise, as viewed in Figure 2, by a spring 178 to a position limited by an adjustable stop 180. A rod 182, arranged to be acted upon by connections to the main cam drum of the machine, is arranged to swing the plate 174 and hook 172 clockwise as viewed in Figure 2 against the action of spring 178.

A wire guide 184 which is carried by the bracket 185 which supports the latch guard 164 has the shape illustrated in the various figures and in particular has corners at 184' and 184'' which, as hereafter described in detail, take part in the proper guidance of the auxiliary yarn B.

The picker 122 is carried by an arm pivoted to the frame at 127, the picker being urged toward a lower position by the action of a spring 131. The picker 124 is similarly carried by an arm pivoted at 129 and urged to move the picker to its lower position by a spring 133.

As was stated above, the pickers 122 and 124 are selectively adapted to raise either one or two lower sliders in a cylinder stroke. To provide for this action, there are provided a pair of cam plates 135 and 147. The cam plate 135 is pivoted at 137 and connected by link 139 to one end of a lever 141 pivoted to the frame at 143, the other end of which lever is connected by link 145 to the cam plate 147 which is pivoted to the frame at 149. A Bowden wire 153 is connected to the lever 141 and is arranged to be acted upon by the main cam drum of the machine. A spring 151 normally urges the lever 141 in a counterclockwise direction, as viewed in plan, and this spring tends to move both cam plates 135 and 147 inwardly to act on the picker supporting levers to move the respective pickers to intermediate positions so that each will raise only one slider at a time the butt of the slider to be raised engaging the lower step of the picker. When, however, the Bowden wire 153 is pulled, the cam plates 135 and 147 release the pickers to their lowermost posi-

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tions in which each is adapted to raise two sliders at a time, the butt of the leading slider to be raised engaging the upper step of the picker while the lower step engages and raises the butt of the second slider to be raised.

At the lower portion of Figure 11, there are indicated in developed form the two positions X and Y alternative-in developed form the two positions X and Y alternative-illustration X of these sinker cams, they are shown in the positions which they occupy relative to the slider cams during run-down operation, i. e., counterclockwise rotation of the cylinders during rotary knitting and counterclockwise reciprocating movement of the cylinders, while in the lower illustration Y they are shown in the positions assumed during reverse reciprocation strokes. The cam 30 is shown as provided with knock-over portions at 186, 188, 190 and 192. As will be evident, the portions 186 and 188 respectively act when stitches are drawn by the stitch cams 92 and 96, whereas the portions 190 and 192 act when stitches are drawn by the cams 98 and 94. Sinker withdrawals are effected by the projections 194, 196 and 198 of the lower cam 32, the upper cam 30 being correspondingly relieved at the positions of these projections. In the lower illustration the same cam portions are illustrated but in positions wherein their numerals are respectively primed.

The starting of a stocking and welt formation is carried out as described in Bristow application, Serial No. 241,434, filed August 11, 1951. The present invention is not concerned with these operations and, hence, they need not be described in detail. A two-feed 1 x 1 rib top may be formed in conventional fashion, the sliders in the upper and lower cylinders following the paths already described. Following this rib top, transfer of sliders is effected in conventional fashion and knitting of the leg takes place for the formation of broad rib structure or links-links structure at two feeds, the sliders again taking the paths described above.

Following the completion of the leg, heel formation takes place as will be presently described in detail. Following this, transfer of sliders is again effected to produce a plain sole and a broad rib or links-links instep, the sole and instep being knit at both feeds while, again, the sliders take the paths already described. The toe may then be knit as described in detail hereafter and, following this, rotary knitting is resumed with all of the needles in the lower cylinder to provide two-feed loopers waste courses.

As already indicated, the invention is primarily concerned with the formation of two-feed heels and toes and the operations involved therein will now be described.

The lower butts of the upper sliders and the upper butts of the lower sliders are long in the instep series and short in the sole series.

As a preliminary to heel formation, all of the needles in the heel or short butt section in the upper cylinder are transferred to the lower cylinder and the long butt instep sliders in the lower cylinder are raised to inactive level above the knitting cams by the positioning of cams 116 and 118 in the positions illustrated at 116' and 118'. The instep needles accordingly hold the stitches last drawn by them in both the upper and lower cylinders, failing to knit at both feeds as the last circular stroke takes place. At the end of this stroke, the short butts of the lower sliders extend from a point just beyond the end of the rise of cam 106 counterclockwise to a position above the cam 112 but short of the picker 122.

The pickers 122 and 124 are now in their lowermost positions by reason of withdrawals of cams 135 and 147.

On the first reverse reciprocating stroke, the leading and second short butts are engaged and raised by picker 124. The remaining short butts pass over the cam 96 and the cam 102, and then pass down the stitch cam 98 to produce drawing of the yarn at the second feed. They then rise over cams 108 and 110 to clear the drawn stitches and pass under cam 94 to effect drawing of the

yarn at the main feed. They then rise over cams 112 and 114 and the leading short butt winds up at a position above the cam 104 short of the picker 124. The trailing short butt at the end of this reverse reciprocation starts from the position above the cam 112, heretofore mentioned, and winds up in a position beyond the top of the rise of cam 114. As a result, all of the short butt sliders controlling needles which took yarns are raised to clearing position.

On the next forward stroke, the now leading short butt and the next following one are picked up by picker 122, while the needles associated with the remaining short butts take yarns at both feeds, passing first over cams 94 and 110, then drawing yarn at the main feed in passing under cam 92, being cleared by the actions of cams 100 and 102, then drawing yarn at the auxiliary feed by passing under cam 96 and being cleared by rising over cams 104 and 106, the trailing short butt winding up at a position beyond the rise of cam 106 while the leading short butt which passed through the knitting wave winds up at a position short of the picker 122.

During counterclockwise or run-down movement of the sliders, the sinker cams occupy the positions illustrated at X in Figure 11. During such operation the cams 186 and 188 are respectively properly positioned to provide knock-over at the main and auxiliary feeds. Cam 186 is then just beyond the lower end of the stitch cam edge 92 and cam 188 is just beyond the lower end of stitch cam 96.

Coincidentally with beginning of reciprocatory knitting, follower 62 is released to follow cam 64. During reverse reciprocation, follower 62 is not engaged by cam 64 and, as a result, spring 46 effects a counterclockwise shift of the sinker cams to position Y. As a result, the positions 183', 186', 190' and 192' are respectively attained by the cams 188, 186, 190 and 192. It will be noted that, under these conditions, the gap at 198' is in the circumferential position of picker 124, a position previously occupied by the knock-over cam 188. It may be noted that the actual shifting movements of the sinker cams occur as long butt sliders are passing the feed points so that the sinker cams are properly positioned when the sinker movements are significant; i. e. when the short butt sliders are passing through their knitting waves.

At gap 198' the sinker hooks are projected outwardly of the needle circle well beyond the shanks of the needles so that as the leading short butt sliders are picked up and the bluff sinkers are raised, yarn will not be trapped between the sinker hooks and the bluff sinker ledges 28. If the sinker cams remained in the run-down position X, knock-over cam 188 would have been at the position of picking and the rise of the bluff sinker might well have trapped yarn. It may be noted that the arrangement for shifting the sinker cams is provided as a result of the picking of two sliders simultaneously since it is the yarn extending between the two picked needles which would be trapped by the bluff sinkers if the cams were not shifted.

When the sinker cams occupy the position Y, the knock-over cam positions are 190' and 192' in proper relationship to the stitch cams 98 and 94, respectively. In this case, also, there is a knock-over cam, at 192', in a position which would interfere with the picking at 122 resulting in possible entrapment of yarn. However, when the sinker cams are in the position X, the gap at 194 will be in the circumferential position of the picker 122 so that trapping of the yarn at the time of picking is avoided.

In the widening operation, the cams 135 and 147 are moved to their active positions to locate the pickers 122 and 124 so as to raise only a single short butt in each stroke. On each forward stroke, the picker 122 will raise the leading active short butt of the short butt series and the dropping picker 120, now lowered to active posi-

tion, will pick down the first three inactive short butts trailing the remaining active short butts, the dropper, after moving downwardly in its picking movement, remaining inactive during the passage of the inactive short butts following those picked down and preceding the long butts, all of the long butts, and then the inactive short butts trailing the long butts. This movement brings beyond the dropper the last of the latter group of short butts which is inactive. On each reverse reciprocation stroke, a similar action occurs, again resulting in picking up of a single leading active short butt and picking down of three short butts, following the series of active short butts.

The resulting stitch structure will be that of Figure 12 in which the main and auxiliary feed yarns are distinguished by shading. It should be noted that during the reciprocatory knitting the courses consist of two successive courses of main feed yarn followed by two successive courses of auxiliary feed yarn, and so on, the last yarn knit during a stroke in one direction being the first knit in the stroke in the opposite direction. In further explanation of the stitch structure shown in Figure 12, it may be noted that the needles picked down follow in knitting sequence those which follow the one picked up in the same stroke.

In the foregoing, no particular mention has been made of the matter of yarn feeds, but it may now be pointed out how these feeds are accomplished consistently with the proper guarding of latches.

In a superposed cylinder machine in which two-feed knitting of heels and toes is not accomplished, and in which a yarn fed at an auxiliary feed point is fed only during rotary knitting, there is no particular difficulty involved in providing for proper guarding of latches of needles in the upper cylinder. But in a machine in which the auxiliary feed is active during reciprocatory knitting, the proper presentation of the auxiliary yarn to the needles is difficult to accomplish consistently with proper latch guarding inasmuch as the yarn shifts back and forth between successive reciprocating strokes and the ends of the latches of the lower cylinder needles must be kept below the yarn lead while the ends of the latches of upper cylinder needles must be kept above the yarn lead, except during clearing. The problem involved is to get the lower cylinder needle latches inside a lower guard and at approximately the same position to get the upper cylinder latches either inside or outside an upper guard, with proper control in either case, while still leaving ample space between the two guards for the yarn to switch back and forth freely. Latch guards alone are not sufficient for control of the latches since latch throw and bounce are not predictable and since clearance must be provided for the knock-over actions of the sinkers and their proper retractions. In particular, the sinkers must be positioned so as not to interfere with the latch guards and the latch guards can only be located where interfering sinker movements would not be required.

By shifting the lead of the auxiliary yarn under different conditions, including feed below the upper edge of the lower guard, the yarn itself assists the latch guards in control of upper cylinder needle latches so that whether or not such a latch may come inside or outside the upper latch guard, it will still be above the yarn lead and cannot close while there is yarn being fed to lower cylinder needles going down the second feed stitch cam. By provision of sinker cams as described the lower section of a second feed latch guard is made possible.

Referring particularly to Figures 1, 2, 3, 4 and 11 the matters of yarn feeding and latch guarding may be made clear. During rotary knitting the auxiliary yarn B is in the B1 position illustrated in Figure 4 (which position is also illustrated in Figure 2), the hook 172 being positioned by spring 173 to draw the auxiliary yarn downwardly so that it approaches the needles from a level below the top edge 165 of the lower latch guard 164 at the

auxiliary feed and extends about the bevelled trailing end 167 of this latch guard.

At the main feed, the needles in the lower cylinder take yarn in passing down the cam 92 and their latches close beyond the trailing end of the latch guard 156, the opening at 152 in the upper main feed latch guard permitting latch closing of upper cylinder needles to take place though, as will be pointed out, this opening provides an unnecessarily large clearance for this purpose and is primarily provided for a different purpose. The needles in the upper cylinder approach guard 156 at cleared level at which their latches are prevented from closing by the empty sliders in the lower cylinder. As they are raised by the action of cam 140, the ends of their latches pass from behind guard 156 to behind guard 150, this passage occurring smoothly because guard 156 is closer to the cylinders than guard 150. The needles in the upper cylinder then take yarn at the main feed in moving up the cam 126. As the needles in the upper cylinder reach the opening 152, their latches may drop but if they do so they will drop upon the main yarn, trapping the same.

As the lower cylinder needles approach the second feed and rise up over cams 100 and 102, their latches open and are trapped behind the guard 158. As their sliders are lowered preliminarily by cam 103 before passing down cam 96, the second feed yarn is above the ends of their latches so that they cannot close without trapping this yarn. During lowering by cam 103, the lower ends of the latches pass from behind guard 158 to a position behind guard 164, and this passage is insured since edge 163 is closer to the cylinder than edge 165.

As the upper cylinder needles are lowered by cams 130 and 132, their latches will be opened by the loops on their shanks and will be held open behind guard 164 until the previous stitches are cleared.

As the upper cylinder needles are raised by their sliders riding up cam 134 their latches pass from behind latch guard 164 near its beveled end 167. These latches may then go behind guard 158 at 163, or in front of this guard. The yarn trailing off the beveled end 167 of guard 164 insures the yarn's getting below the end of the latches of these upper needles so that as the latches close at cut-out 162, or fall because of passing in front of guard 158, they fall on the yarn and guide it into their hooks at the proper time.

During reciprocation, since all needles are in the lower cylinder, only the guarding of lower cylinder latches need be considered.

It may be here remarked that the guarding of picked and instep needles (whether in the upper or lower cylinder) is effected by the corresponding empty sliders. The empty sliders in the upper cylinder opposite the heel needles guard these when they are at cleared level.

During forward reciprocatory strokes the events which occur are similar to those involved in rotary knitting, but the feed of yarn at the auxiliary feed is somewhat different, the hook 172 being out of action and the yarn being led, as indicated at B₂ from the corner 184' of the wire loop 184. Under these conditions, it is led from a higher level so as to be approximately at the level of the opening between the upper and lower latch guards at the auxiliary feed so as to pass freely back and forth between them during changes in the directions of the reciprocating strokes. During heel and toe knitting yarn is fed only to the lower cylinder needles and thus the yarn can be fed high above the ends of the latches of these needles since there are no latches of upper cylinder needles requiring the yarn to be fed low to them; and this makes it possible to feed the yarn high enough to pass freely between the latch guards as it reciprocates, feeding to needles knitting first in one direction, then in the other.

During the reverse reciprocating strokes, the auxiliary yarn lead is as indicated at B₃, the yarn approaching

the needles from the corner 184' of the loop 184. Under these conditions, it approaches the needles somewhat higher than during reciprocation in the forward direction. This insures that the yarn will be above the lower ends of the latches as the sliders rise over cam 102. The latches of the active needles are open at cleared level and are guarded initially at this level by the empty upper cylinder sliders. The latches then pass behind the upper guard 158 which holds them open until, when they close, they will be in position to trap the auxiliary yarn. The opening at 152 in the upper latch guard at the main feed is to permit the latches to open as the needles rise over cams 108 and 110.

From the foregoing, it will be observed that the yarn feeding, latch guarding and sinker operations are rendered consistent with each other for the production of two-feed heels and toes as well as two-feed legs of stockings.

There is illustrated in Figure 13 a typical sock produced by the machine heretofore described. The welt region is indicated at C followed by a rib top D and leg E. The rib top and leg are knit two-feed with resulting increase in rate of production. Just prior to formation of the heel, rib needles at the rear of the sock are transferred to the lower cylinder for the formation of a plain rear portion F. The heel G is knit two-feed, as described above. The instep and sole H and J, respectively, are then knit two-feed, the sole being shown as a plain sole knit with all of the needles in the lower cylinder. Following this the instep needles previously knitting ribs are transferred to the lower cylinder for the formation of a number of courses at K of plain two-feed type. The toe is then knit two-feed as indicated at L and this is followed by the knitting of two-feed plain courses at M to provide the loopers waste courses.

It will be evident that two feed heels and toes may be knit utilizing various matters of the present invention but with the same variations as described in the patent to Robert H. Lawson No. 2,440,280. Gussets may also be provided in accordance with the patent of Grothey and Lawson, No. 2,590,008, issued March 18, 1952.

It will, of course, be evident that with proper pattern controls provided for the sliders the needles may be transferred selectively between the upper and lower cylinders for the formation of links-links work instead of the broad rib structure.

What is claimed is:

1. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarns to needles at two feed points, cams for moving moving needles to form stitches at both of said feed points during reciprocations in both directions, sinkers cooperating with the needles in the formation of stitches, sinker cams for imparting movements to the sinkers, and means for effecting for each reciprocation of the needle cylinder a shift of said sinker cams about the cylinder axis which is opposite the direction of reciprocation of the needle cylinder.

2. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, means for picking out of action a pair of adjacent needles during each reciprocation of the needle cylinder, sinkers cooperating with the needles in the formation of stitches, sinker cams for imparting movements to the sinkers, and means for effecting for each reciprocation of the needle cylinder a shift of said sinker cams about the cylinder axis which is opposite the direction of reciprocation of the needle cylinder.

3. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, needles slidable in said cylinders, means

for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, sinkers cooperating with the needles in the formation of stitches, sinker cams for imparting movements to the sinkers, and means for effecting for each reciprocation of the needle cylinders a shift of said sinker cams about the axis of the cylinders which is opposite the direction of reciprocation of the needle cylinders.

4. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, needles slidable in said cylinders, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, means for picking out of action a pair of adjacent needles during each reciprocation of the needle cylinders, sinkers cooperating with the needles in the formation of stitches, bluff sinkers associated with needles which are arranged to knit during reciprocation, sinker cams for imparting movements to the sinkers and bluff sinkers, and means for effecting for each reciprocation of the needle cylinders a shift of said sinker cams about the axis of the cylinders which is opposite the direction of reciprocation of the needle cylinders.

5. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarns to needles at two points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, sinkers cooperating with the needles in the formation of stitches, sinker cams for imparting movements to the sinkers, means for effecting for each reciprocation of the needle cylinder a shift of said sinker cams about the cylinder axis which is opposite the direction of reciprocation of the needle cylinder, and means for maintaining during rotary knitting said sinker cams in the position assumed for a forward reciprocation.

6. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, needles slidable in said cylinders, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, sinkers cooperating with the needles in the formation of stitches, sinker cams for imparting movements to the sinkers, means for effecting for each reciprocation of the needle cylinders a shift of said sinker cams about the axis of the cylinders which is opposite the direction of reciprocation of the needle cylinders, and means for maintaining during rotary knitting said sinker cams in the position assumed for a forward reciprocation.

7. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, needles slidable in said cylinders, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, means for picking needles out of action, and means selectively controlling said picking means to produce, alternatively, the picking of a pair of adjacent needles during each reciprocation of the needle cylinders or the picking of a single needle during each reciprocation of the needle cylinders.

8. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, latch needles slidable in said cylinders, means for feeding a yarn to needles at a feed point, cams for moving needles to form stitches at said feed point during reciprocations in both directions, and upper and lower latch guards at said feed point, said guards having respective lower and upper edges providing between them a restricted passage for said yarn, said yarn feeding means including means for guiding said yarn for free movement

through said passage during changes of direction of the reciprocatory movements of said needle cylinders.

9. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, latch needles slidable in said cylinders, means for feeding a yarn to needles at a feed point, cams for moving needles to form stitches at said feed point during reciprocations in both directions, and upper and lower latch guards at said feed point, said guards having respective lower and upper edges providing between them a restricted passage for said yarn, said yarn feeding means including means providing different points of approach of the yarn to the needles during the opposite reciprocatory movements of said needle cylinders.

10. A knitting machine comprising superposed needle cylinders, means for imparting reciprocatory movements to said cylinders, latch needles slidable in said cylinders, means for feeding a yarn to needles at a feed point, cams for moving needles to form stitches at said feed point during reciprocations in both directions, and upper and lower latch guards at said feed point, said guards having respective lower and upper edges providing between them a restricted passage for said yarn, said yarn feeding means including means for guiding said yarn in paths of approach to the needles during both directions of reciprocation of the needle cylinders such that the approaching yarn will prevent closure of needle latches after clearing.

11. A knitting machine comprising superposed needle cylinders, means for imparting rotary movements to said cylinders, latch needles slidable in said cylinders, means for feeding a yarn to needles at a feed point, cams for moving needles to form stitches at said feed point, and upper and lower latch guards at said feed point, said guards having respective lower and upper edges providing between them a restricted passage for said yarn, said yarn feeding means including means for guiding said yarn to approach the needles across an edge of one of said latch guards.

12. A knitting machine comprising superposed needle cylinders, means for imparting rotary movements to said cylinders, latch needles slidable in said cylinders, means for feeding a yarn to needles at a feed point, cams for moving needles to form stitches at said feed point, and upper and lower latch guards at said feed point, said guards having respective lower and upper edges providing between them a restricted passage for said yarn, said yarn feeding means including means for guiding said yarn to approach the needles across an edge of one of said latch guards, so that said yarn will prevent closure of needle latches after the needles pass the last mentioned latch guard.

13. A knitting machine comprising superposed needle cylinders, means for imparting rotary and reciprocatory movements to said cylinders, needles slidable in said cylinders, means for transferring needles between said cylinders, means for feeding a yarn to said needles at each of a pair of feed points, cams at said feed points for controlling the needles to form stitches at both of said feed points, and means for effecting production of two feed knitting concurrently with narrowing and widening to produce fabric pockets.

14. A knitting machine comprising superposed needle cylinders, means for imparting rotary and reciprocatory movements to said cylinders, needles slidable in said cylinders, means for transferring needles between said cylinders, means for feeding a yarn to said needles at each of a pair of feed points, cams at said feed points for controlling the needles to form stitches at both of said feed points, and means for effecting production of two feed knitting concurrently with narrowing and widening to produce fabric pockets, the last mentioned means including picking devices for removing from action two needles upon each reciprocatory stroke of the needle cylinders during narrowing and for restoring to action three needles and for removing from action one needle upon each re-

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ciprocatory stroke of the needle cylinders during widening.

15. A knitting machine comprising superposed needle cylinders, means for imparting rotary and reciprocatory movements to said cylinders, needles slidable in said cylinders, means for transferring needles between said cylinders, means for feeding a yarn to said needles at each of a pair of feed points, cams at said feed points for controlling the needles to form stitches at both of said feed points, and means for effecting production of two feed knitting concurrently with narrowing and widening to produce fabric pockets, the last mentioned means including picking devices for removing from action two needles upon each reciprocatory stroke of the needle cylinders during narrowing and for restoring to action a plurality of needles and for removing from action two less than said plurality of needles upon each reciprocatory stroke of the needle cylinders during widening.

16. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarn to said needles, means for picking out of action a pair of adjacent needles during each reciprocation of the needle cylinder, sinkers cooperating with the needles in the formation of stitches, and means for retracting sinkers at the location of said picking means.

17. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocation in both directions, means for picking out of action a pair of adjacent needles during each reciprocation of the needle cylinder, sinkers cooperating with the needles in the formation of stitches, and means for retracting sinkers at the location of said picking means.

18. A knitting machine comprising superposed needle cylinders, means for imparting rotary and reciprocatory movements to said cylinders, latch needles slidable in said cylinders, means for feeding yarns to needles at two feed points, cams for moving needles to form stitches at both of said feed points during reciprocations in both directions, and latch guards for guarding latches of needles in both the upper and lower cylinders during rotary knitting and for guarding latches of needles in the lower cylinder during reciprocatory knitting.

19. The method of knitting a stocking on an independent needle knitting machine comprising forwardly and reversely concatenating loops to provide a leg portion thereof, forming a heel pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, forwardly and reversely concatenating loops to provide a foot portion thereof, and forming a toe pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction.

20. The method of knitting a stocking on an independent needle knitting machine comprising forwardly and reversely concatenating loops to provide a leg portion thereof, forming a heel pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, forwardly and reversely concatenating loops to provide a foot portion thereof, and forming a toe pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, each of said pockets involving, during narrowing, removal from action of two needles upon each reciprocation and, during widening, restoration to action of three needles and removal from action of one needle upon each reciprocation.

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21. The method of knitting a stocking on an independent needle knitting machine comprising forwardly and reversely concatenating loops to provide a two feed leg portion thereof, forming a heel pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, forwardly and reversely concatenating loops to provide a two feed foot portion thereof, and forming a toe pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction.

22. The method of knitting a stocking on an independent needle knitting machine comprising forwardly and reversely concatenating loops to provide a two feed leg portion thereof, forming a heel pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, forwardly and reversely concatenating loops to provide a two feed foot portion thereof, and forming a toe pocket by reciprocatory knitting of two yarns knit in successive courses during reciprocation in each direction, each of said pockets involving, during narrowing, removal from action of two needles upon each reciprocation and, during widening, restoration to action of three needles and removal from action of one needle upon each reciprocation.

23. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, latch needles slidable in said cylinder, means for feeding yarn to said needles, means for picking at least one needle out of action during each reciprocation of the needle cylinder, sinkers cooperating with the needles in the formation of stitches, and movable means for retracting sinkers at the location of said picking means during picking actions thereof, said retracting means being at other times ineffective to retract sinkers at the location of said picking means.

24. A knitting machine comprising a needle cylinder, means for imparting reciprocatory movements to said cylinder, needles slidable in said cylinder, means for feeding yarn to said needles, sinkers having nebs cooperating with said needles to form stitches, bluff sinkers associated with sinkers having nebs, means for picking at least one needle out of action during each reciprocation of the needle cylinder, means effecting movement of said bluff sinkers concurrently with picking of needles, and means for retracting sinkers at the location of said picking means to avoid trapping of yarn between bluff sinkers and associated sinker nebs during picking.

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